PATENT SPECIFICATION

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(54) VACUUM CONVEYING SYSTEMS

(71) We, MUCON ENGINEERING COMPANY LIMITED, a British Company, of Winchester Road, Basingstoke, Hampshire, England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to conveying systems for granular, particulate, and pulverulent material of the kind in which the material to be conveyed is entrained in an air flow produced between a supply container of the material and a receiver by causing a negative pressure differential between the receiver and the supply container. Such systems are commonly referred to as vacuum conveying systems.

In known systems of this kind, when the receiver, which is generally a hopper, is filled it is necessary to break the partial vacuum within it so that it can be emptied, with the result that the material is conveyed in intermittent fashion and the means for producing the required vacuum is inoperative for a substantial part of the working cycle of the system. Hitherto, attempts to produce continuous conveying have involved the use of complex and expensive rotary valve air locks. Apart from their initial costs, these air locks have required frequent maintenance, particularly where the material to be conveyed has been of a gritty or abrasive nature.

It is the object of the present invention to provide an improved conveying system which permits conveying on a continuous basis without the disadvantages inherent in the use of rotary valves.

In accordance with the invention, a receiver for a vacuum conveying system comprises twin receiving vessels each naving a connection for a supply container, a further connection for a control valve for a source of vacuum, non-return valve means to close each receiving vessel in the absence of a vacuum therein, from its connection for the supply container, a discharge orifice at the bottom of each of the receiving vessels, and discharge valve means adapted to open each discharge orifice when its respective vessel is filled and in the absence of a vacuum therein, and wherein the discharge orifices are in adjacent relationship and the discharge valve means comprises two flaps in a fixed mutual relationship mounted on a pivot so as to be rotatable between two extreme positions at which the flaps alternately seal their respective discharge orifices, an over-centre spring mechanism being provided to bias the flaps alternately into their sealing positions as the flaps move about their pivot past a midway position.

The invention also includes a vacuum conveying system comprising the receiver, a control valve between the receiver and a source of vacuum therefor, and operable to selectively open each one of the receiving vessels in turn to the vacuum source and simultaneously vent the other one of the receiving vessels to atmosphere, and a supply vessel connected to the receiver.

It should be understood that the term "vacuum" as used throughout this specification is intended to mean a condition in which the air pressure within a space is below that of the atmosphere. In general, in the practice of the invention the vacuum produced will be of the order of fifty to three hundred inches of water.

A preferred control valve means comprises a slide valve movable to connect two ducts leading to the receiving vessels alternately with a duct from the vacuum source and a vent pipe.

A preferred embodiment of the invention will now be described with reference to the accompanying drawings wherein:—

Figure 1 shows diagrammatically a vacuum conveying system incorporating two

receivers, in accordance with the invention, arranged in series,

Figure 2 shows a side elevation, partly broken away, of a receiver, for use in the system shown in Figure 1,

Figure 3 shows a plan view of the receiver with filters removed,

Figure 4 shows a section on an enlarged scale of a detail on the line IV-IV in Figure 2,

Figure 5 shows a side view of a control valve,

Figure 6 shows an underneath view of the control valve, and

Figures 7, 8 and 9 show, respectively, a detail of the control valve in part-sectioned side elevation, plan, and section on the line IX-IX of Figure 7.

The system shown in Figure 1 is constructed to convey powder or other particulate material from a replenishable supply hopper 1 to a bulk container 2 in two stages. In the first stage the material is conveyed to a receiver 3 from which it is deposited into an intermediate hopper 4 through a mixing device 5, and in the second stage the material is conveyed from the hopper 4 to a second receiver 3*a* from which it is deposited into the container 2. The receivers 3 and 3*a* are connected respectively to the hoppers 1 and 4 by pipe ducting 6, 7 and to air exhaust units 8, 9 by pipes 10, 11 through control valves 12, 12*a*.

As will presently be described in detail each receiver includes twin receiving vessels which are filled in turn with material drawn through the pipes 6 and 7 from the hoppers 1 and 4 when the valves 12, 12*a* are set to connect a vacuum set up by the exhaust units 8 and 9 to be applied to the vessels. When the vessels are filled, operation of the control valve vents the filled vessels so that their contents are deposited in the hopper 4 and container 2 and at the same time the vacuum is applied to the other vessel in each receiver to cause it to be filled with material. The alternate filling and emptying of each vessel of each receiver may be continued indefinitely as long as a supply is maintained in the hopper 1. The exhaust units 8, 9, the hopper 1 and container 2 are of known conventional constructions and will not be further described and the hoppers 1 and 4 are dispensing containers adapted to entrain the material in an air flow in proportions such as to obtain satisfactory conveyance of the material by the air flow.

Each receiver 3 and 3*a* is shown in greater detail in Figures 2-4. It comprises a body 20 providing twin vessels 21 in side-by-side relationship and each having a cylindrical upper part 22 joined to a cone shaped dispensing part 23 which has its conical extremity cut away to leave an elliptical outlet orifice 24. A pipe connection 25 attachable to the pipe duct 6 or 7 leads tangentially into each part 22 so that material entraining air flowing into either vessel forms a vortex flow within it. The entry port of the connection to each vessel is covered by a flexible flap valve 26 which automatically opens when the vessel is subject t vacuum and closes when the vacuum is broken by the control valve 12 or 12*a*.

The control valve is connected to each vessel by exhaust pipes 27 forming air outflows from filter assemblies 28 mounted on top of and communicating with the interiors of the vessels 21. Each filter assembly comprises a cylindrical chamber 29 enclosing a cylindrical filter cloth 30 enclosing a support frame 31. A removable cover 33 secured by clamping screws and thumb nuts 33 and forming a mounting for the pipe 27 gives access to the filter cloth. The filters trap any material remaining in the air flow through the vessels and not deposited within the vessels by the vortex movement of the air therethrough. The material thus trapped by the cloths and retained on their surfaces is deposited in the vessels when the vacuum is broken and air rushes in from the control valve in a direction opposite to the normal flow. In this way the filters are substantially cleaned by the reverse flow of air expanding the filter cloths and blowing off residual particulate material loosened by the sudden expansion.

The orifices 24 are selectively opened and closed by a flap valve arrangement 40 between them. This comprises two flaps 41 faced with resilient sealing pads 42, joined together, and mounted on a common fixed spindle 43 by journals 47 rotatably carried by bushes 48 screwed onto the spindle ends. The flaps are spaced so that when either flap is in sealing relationship with its corresponding orifice 24, the other flap is clear of its orifice, and rotation of the flaps about the common spindle closes one orifice as the other is opened. In Figure 2 the flaps are shown in the intermediate position.

In order to ensure correct emptying of each vessel in turn the flaps must maintain each orifice closed until the vacuum within the corresponding vessel is broken, i.e. each flap must be held closed against the weight of the contents of the filled vessel while the pressure within the vessel is below atmospheric. When the vacuum is broken the weight of the contents acts upon the valve to induce movement of the valve through the centre position thus moving the other valve flap into closed sealing relation with its corresponding orifice. To assist this movement and ensure a quick change-over movement of the flaps they are loaded by an over-centre spring arrangement comprising two compression springs 45, one at each end of the spindle 43 located between fixed

abutments and pegs 46 mounted on the journals 47 of the flaps.

Each control valve (Figures 5-9) comprises two inlet stubs 50, 51 connected to the pipes 27 and three outlet stubs 52, 53, 54 in line. The two outermost outlet stubs 52, 54 are vented to atmosphere and the centre stub 53 is connected by the pipe 10 or 11 to one of the exhaust units. A slide valve assembly 55 is mounted adjacent the outlet stubs and has two valve stubs 56, 57 joined by flexible ducts 58, 59 to the stubs 50, 51. The slide assembly can be moved between extreme positions under the control of a pneumatic actuator 60. In one position, as shown in Figure 5 stub 53 is connected to stub 50 and stub 54 is connected to stub 51. As a result one of the receiver vessels is put in communication with the exhaust unit and the other vessel is vented to atmosphere. In the other position, stub 52 is connected to stub 50 and stub 53 is connected to stub 51. Accordingly the one vessel is now vented and the other vessel is in communication with the exhaust unit.

The valve assembly 55 comprises an apertured sliding valve plate 61 having a sealing layer 62 on its underside which lies in surface contact with a base plate 63 carrying the outlet stubs. Ports in the valve plate opening into stubs 56 and 57 selectively register with the stubs 52, 53, or 53, 54. Guide plates 64 are bolted to the sides of the valve plate 61 and their lowermost edges are flanged to form mountings for antifriction strips 65. The strips 65 are pressed against the underside of the base plate 63 by means of resilient buffers 66 and thus hold the plate 61 closely in contact with the base plate. Adjustment of the pressure between the valve plate 61 and the base plate 63 is obtained by means of adjustment screws 73 which can be used to alter the vertical setting of the guide plate 64 relative to the valve plate.

The actuator 60 includes a sliding piston rod which is connected to the plate 61 by a cross-head 67. The cross-head is screwed to lugs 68, the lugs being joined to further lugs 69 by straps 70. The lugs 69 are mounted on a spindle 74 carried by a pillar 75 bolted to the valve plate 61. The control valve is enclosed by a casing 71 (one wall of which is shown removed in Figure 5) provided with mounting brackets 72.

Movement of the control valve may be controlled by a timing mechanism set to operate after a predetermined period sufficient to enable each of the hoppers to be filled, or by a signal from a sensing mechanism which is actuatable when the contents reach a predetermined amount.

WHAT WE CLAIM IS:—

1. A receiver for a vacuum conveying system comprising twin receiving vessels each having a connection for a supply container, a further connection for a control valve for a source of vacuum, non-return valve means to close each receiving vessel in the absence of a vacuum therein, from its connection for the supply container, a discharge orifice at the bottom of each of the receiving vessels, and discharge valve means adapted to open each discharge orifice when its respective vessel is filled and in the absence of a vacuum therein, and wherein the discharge orifices are in adjacent relationship and the discharge valve means comprises two flaps in a fixed mutual relationship mounted on a pivot so as to be rotatable between two extreme positions at which the flaps alternately seal their respective discharge orifices, an over-centre spring mechanism being provided to bias the flaps alternately into their sealing positions as the flaps move about their pivot past a mid-way position.

2. A receiver according to claim 1 wherein each receiving vessel comprises a cylindrical upper part and a cone-shaped lower part terminating in the discharge orifice.

3. A receiver according to claim 2 wherein the connections for the supply container lead into the cylindrical parts tangentially so as to produce a vortex flow of incoming air.

4. A receiver according to any of claims 1-3 wherein each receiving vessel has a filter on which the control valve connection is mounted for removing any remaining material from the air flow through the vessel.

5. A receiver according to claim 4 wherein the filter comprises a housing mounted on top of and open to the interior of the receiving vessel, the housing containing a frame to support a cylindrical filter cloth between the receiving vessel and the control valve connection.

6. A receiver constructed and arranged substantially as hereinbefore described and shown in Figures 1-4 of the accompanying drawings.

7. A vacuum conveying system comprising a receiver according to any of claims 1-6, a control valve between the receiver and a source of vacuum therefor, and operable to selectively open each one of the receiving vessels in turn to the vacuum source and simultaneously vent the other one of the receiving vessels to atmosphere, and a supply vessel connected to the receiver.

8. A vacuum conveying system according to claim 8 wherein the control valve comprises a slide valve assembly movable to selectively connect two ducts, each leading to one of the receiving vessels, alternatively with the vacuum source and a vent to atmosphere.

9. A vacuum conveying system according to claim 8 wherein the slide valve assembly comprises an apertured plate slidable upon a base plate having three connector stubs

arranged in line, the centre stub being connected to the vacuum source and th outer stubs being open to atmosphere, the apertured plate having two ports registerable with the stubs and communicating through flexible ducts to further connector stubs connected to the two receiving vessels respectively.

10. A vacuum conveying system according to any of claims 7-9 having a further receiver and control valve connected to a vacuum source, said further receiver being connected to a second supply vessel which is positioned to be filled by the first-mentioned receiver.

11. A vacuum conveying system substantially as hereinbefore described and shown in the accompanying drawings.

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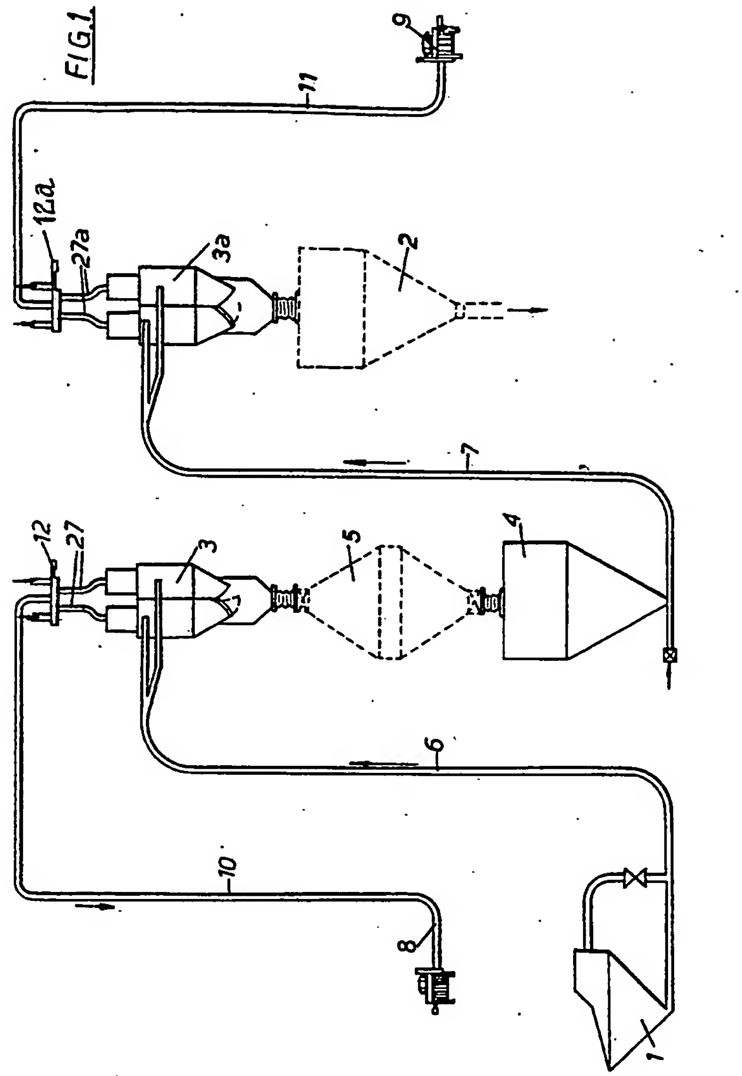

FIG.1

FIG.2.

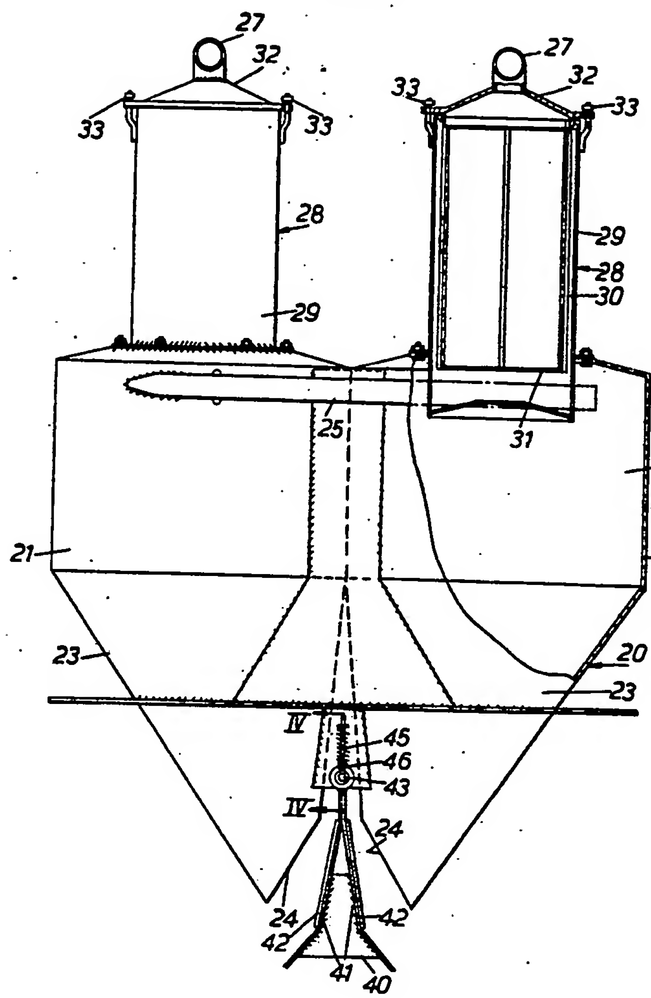
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FIG.3.

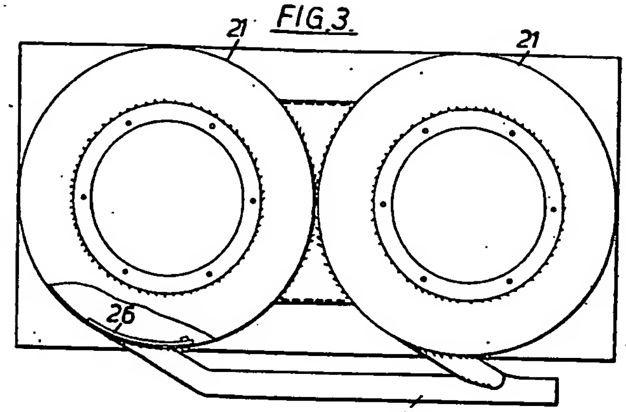


FIG.4.

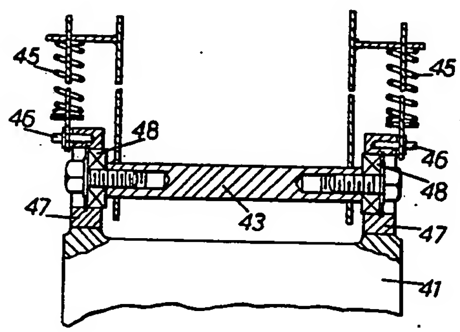
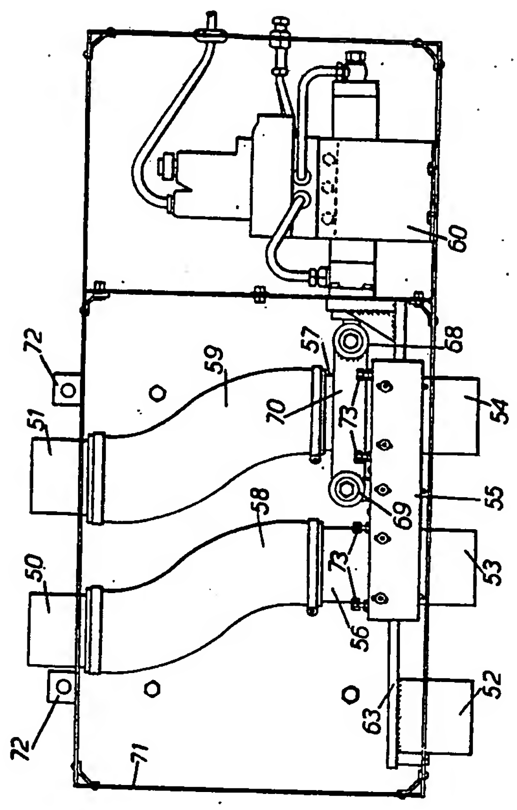


FIG.5



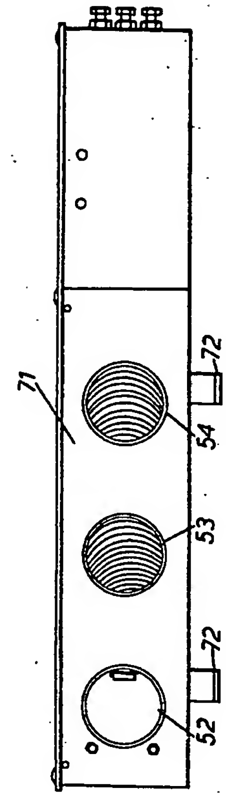
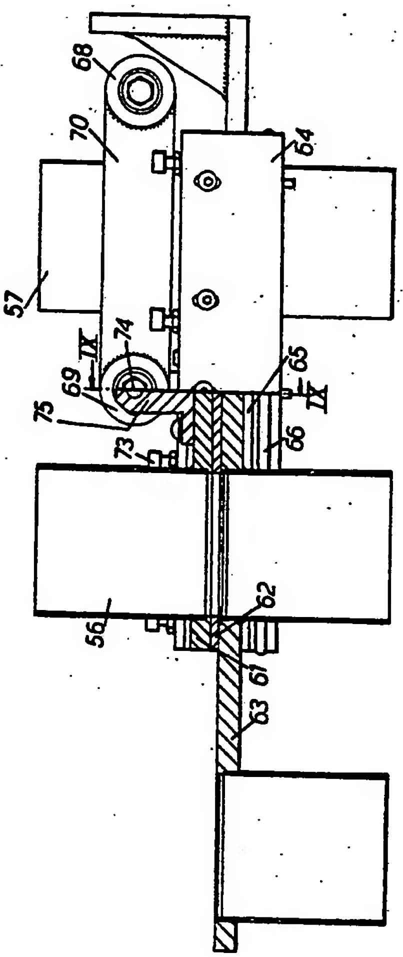


FIG.6

FIG.7



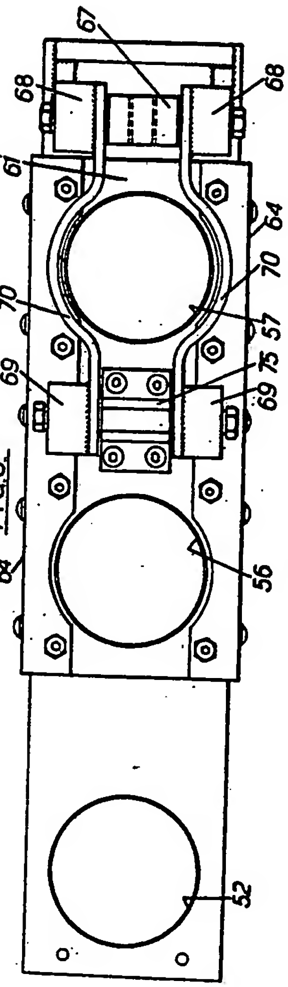

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FIG.8

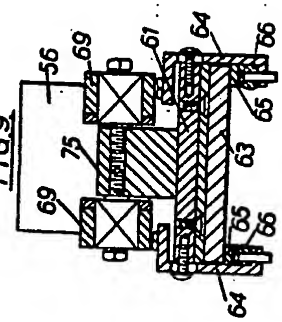
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FIG.9